FACTS

Ontario
Ministry of the Environment

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WFS6

ABOUT WATER

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INTRODUCTION TO WATER POLLUTION CONTROL

"We travel together, passengers on a little space ship, dependent on its vulnerable supplies of air, water and soil — preserved from annihilation by the care, the work, and I will say, the love we give our fragile craft."

Adlai Stevenson.

An informed public is vitally important in the battle for an improved environment. Governments can proceed only as fast as public opinion dictates. For this reason, it is the responsibility of each of us to spread accurate, factual information about water pollution.

The subject of pollution can be quite complicated and very technical. Because of this, the problems are frequently oversimplified. A detailed understanding of all aspects of pollution really requires a great abundance of reading. And with this in mind, we will try in this publication to put down some basic facts that may help in the search for information.

Introduction

What is meant by pollution? The Oxford Concise Dictionary states that to "pollute" is to "destroy the purity of; make foul or filthy". It sounds simple enough, but pollution means different things to different individuals, and even different things to the same person under different circumstances.

For example, distilled water is commonly considered the purest form of water. Yet, from the standpoint of a fisherman, a lake filled with distilled water would be "polluted", because it would lack the nutrients and minerals necessary for the growth of micro-organisms, invertebrates, and other creatures that serve as food for fish. As a result, fish would not survive in such a lake.

On the other hand, seawater contains a very large quantity of dissolved salts. Yet many marine organisms and fish flourish in it. From this point of view, the oceans could not be called "polluted". However, seawater, because of its salt content, is unsuitable for drinking, irrigation, and many industrial uses. For these purposes it could be considered as contaminated.

Pollution is usually associated with man and his various activities. However, many sources of pollution occur naturally. When leaves fall from trees that overhang bodies of water, organic pollution takes place. Where marshes exist, bacterial organisms enter the water course as a result of decay of aquatic reeds. This natural decay may cause high bacteria counts, which may be wrongly interpreted as indicating pollution from sewage containing disease bacteria and viruses.

Nature's ability to cleanse water exceeds its capacity to pollute it. Nature cleanses water through natural interaction of sunlight, dissolved oxygen extracted from the atmosphere, and by micro-organisms, minute forms of plant and animal life. Nature can cleanse water that has been polluted by natural means, and also in many cases by man-made sources.

However, when man overloads the natural purifying mechanisms of nature or introduces materials that cannot be naturally assimilated, trouble occurs. We then face situations which may be unsightly, unpleasant, or even hazardous to health. It must also be remembered that as the number of humans on the earth increases, with a corresponding increase in technological capabilities, the possibility of the abuse of nature's mechanism becomes much greater.

Water pollution can be divided into two categories: surface water pollution of lakes, rivers, and streams; and ground water pollution of underground water reservoirs called "aquifers". About 40 percent of Ontario's population obtains its drinking water from ground water that comes from wells of one sort or another. For this reason, pollution of ground water is a very serious occurrence. Natural purification processes below ground are very slow, adding further to the seriousness of ground water pollution. This is why sanitary landfill methods of solid waste dis-

posal, as well as other potential sources of ground water contamination, are now being watched so closely by the Ministry of the Environment. Organic matter in discarded waste decays or ferments and persistent materials such as salts percolate down to the aquifers.

Surface water pollution can come from many sources. Some of the major classes of pollution are: natural, domestic, industrial, municipal storm drainage, and agricultural. The natural source has already been dealt with. In most areas of Ontario, it does not seriously interfere with water use.

Domestic and industrial wastes in most municipalities are carried to municipal sewage treatment plants by a network of sanitary sewers. At the treatment plant, most of the polluting material is removed. The remaining wastewater is disinfected and discharged to a nearby lake or river. In many cases, the waste treatment is adequate and water quality and use in the vicinity of the discharge area are not impaired. In some instances, however, treatment does not eliminate all polluting materials, and unsatisfactory water quality conditions persist for many miles downstream from the discharge point.

Municipal storm drainage, along with run-off water from streets, parking lots, and roofs

Chemical content of water

Symbol	Substance	Source	Effect
SiO_2	Silica	Clay minerals, opal, rock minerals	Forms scale on boilers and steam turbines, inhibits pipe corrosion.
Fe	Iron	Igneous and sandstone rocks, iron pipes, pumps, storage tanks, etc.	Stains plumbing fixtures laundry and cooking utensils; spoils water taste and color.
Mn	Manganese	Soils and sediments, metamorphic and sedimentary rock.	Has undesirable taste, leaves deposits on food during cooking, stains plumbing fixtures and laundry.
Ca	Calcium	Gypsum, calcite clay, limestone, rock minerals.	Combines with other minerals to form scale in boilers; inhibits formation of soap suds.
Mg	Magnesium	Limestone, clay, rock minerals.	Same effects as Calcium.
Na	Sodium	Clay, sediments, industrial wastes, rock minerals.	Produces scale and corrosion in boilers; combines with potassium carbonate to cause wood deterioration.
K	Potassium	Micas, clay, rock minerals.	Same effect as Sodium.
HCO_3	Bicarbonate	Limestone.	Combines with other minerals to form scale in pipes.
CO_3	Carbonate	Limestones.	Same effect as bicarbonate.
SO_4	Sulphate	Oxidation of sulphide ores, sulphate minerals, industrial wastes.	Forms scale, causes bitter taste, may be cathartic.
Cl	Chloride	Sedimentary and igneous rocks, salty water forced upstream into tidal estuaries.	Has a salty taste, can be harmful to health.
F	Fluoride	Rock minerals, fluorite, mica.	Increases resistance to tooth decay but, in excess, may cause mottling of tooth enamel.
NO_3	Nitrate	Atmosphere, legumes, plant debris, animal excrement, nitrogenous fertilizers, sewage.	Has a bitter taste, harmful in excess, especially to infants.
$CaCO_3$	Calcium Carbonate	Limestone.	Inhibits formation of soap suds, forms an insoluble scum or curd in washing machines.

of buildings, following a rainfall, are directed to a complex drainage system. In most municipalities, this storm drainage system is independent of the sanitary sewer system. The storm drainage is directed to the nearest water course, usually without any form of treatment. However, some municipalities with old sewer systems have storm drainages flowing into sanitary sewers and then to the sewage treatment plant. This presents one major drawback. Following a heavy storm, a portion of the storm drainage, combined with the domestic and industrial effluent it carries, is bypassed directly into a water course because the sewage treatment plant cannot process such large volumes. This direct discharge generally receives no treatment, or at the very most, disinfection.

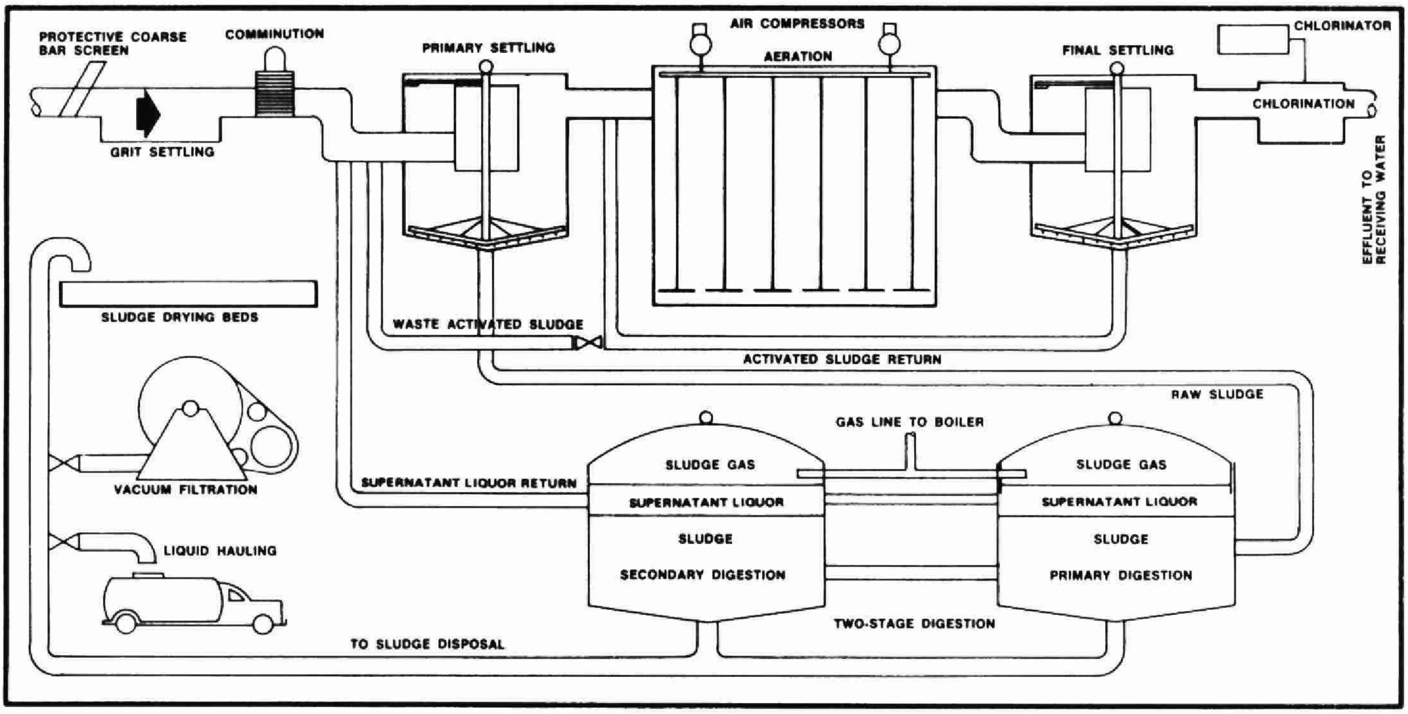
Agriculture also contributes to water pollution. Materials such as fertilizers and pesticides are continuously washed from the surface of the land by sheet erosion in spring or by heavy downpours at any time when the ground is bare. They also percolate through the soil to end up in rivers and lakes. In the case of tile-drained fields, they are carried by the drains into ditches, and from there to water courses. Drainage from feedlots, silos, and manure piles are other sources of pollution from agricultural activities.

Pollutants can be subdivided into two general classes: organic and inorganic wastes. **Organic wastes** use oxygen, and are therefore capable of being reduced to stable substances by biological treatment or by natural processes in a water course utilizing micro-organisms and oxygen dissolved in the water. **Inorganic wastes,** on the other hand, are comprised of salts, heavy metals, and particulate matter such as clay and sand, plus many other components. Some inorganic wastes can be removed by physical or chemical means, but conventional waste treatment methods are usually ineffective in removing many of these waste materials.

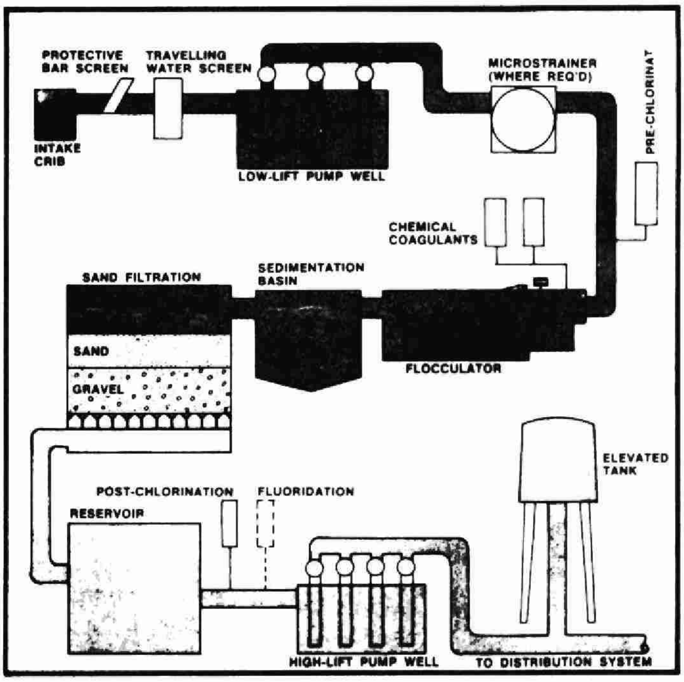
High on the list of organic pollutants is the material associated with **bacteriological pollution** — the fecal or natural body wastes of man and animals. When water contains a high fecal bacteria count, it suggests that disease-carrying organisms may also be present. That is why a high fecal coliform count indicates the possible presence of disease bacteria and viruses. Infectious hepatitis, diarrhea, dysentery, and typhoid are a few of the diseases carried by water.

In order for water to be considered satisfactory for drinking, it must classify with a '0' coliform count on at least monthly samples. Guidelines for water quality for municipal supplies, as well as agricultural and industrial uses, are contained in a publication of the Ministry of the Environment entitled "Guidelines and Criteria for Water Quality Management in Ontario".

Bacterial pollution generally stems from inadequate disinfection at sewage treatment plants, from septic tanks that are opera-



POLLUTION CONTROL, SECONDARY TREATMENT - ACTIVATED-SLUDGE PROCESS. Raw wastes are first passed through protective coarse screens to remove large material. This is followed by grit settling where inorganic matter is precipitated out before the wastes are passed through a comminutor that shreds the remaining solids. Primary settling is next where organic solids are collected and piped as raw sludge to the primary digestion tank. Liquid wastes drawn from the top of the primary settling tank are passed to the aeration tank where micro-organisms, promoted by air pumped into the tank contents, oxidize the organic fraction of the waste. This oxidized waste is then held for a brief period in a final settling tank - the sludge thus settling being termed activated sludge, which is pumped back to the inlet of the aeration tank. Clarified liquid decanting from the settling tank is chlorinated before discharge. Sludge collected in the digesters is held in a closed environment where anaerobic bacteria further oxidizes it. Supernatant liquor drawn from each digester is piped back to the inlet of the primary settling tank; sludge-gas, generated by the digestion process, is either flared off or used to produce heat. Fully digested sludge is piped away for disposal.



WATER SUPPLY - SURFACE WATER SOURCE. Raw water drawn from a surface supply is first passed through a protective bar screen to remove large objects and debris. Next, a travelling screen removes smaller solid objects before low-lift pumps raise the water to the treatment plant. Should water conditions demand it, a microstrainer is employed to remove algae and large particulate matter. Following pre-chlorination, chemical coagulants are added and the water is passed through a flocculation tank where gentle mixing takes place prior to settlement in a sedimentation basin. Any finely suspended matter still remaining in the water is then removed in the filter bed, from which the water is passed to a reservoir. Finally, following post-chlorination (and fluoridation in some cases), the now treated water is pumped to an elevated tank and into the distribution system.

ting poorly or have been poorly installed, or from drainage from farm barnyards and livestock feedlots. Technology to control this type of pollution has been available for many years.

Phosphorus is another waste constituent of importance. It can be present in large quantities in domestic sewage, industrial waste, and agricultural discharges. Phosphorus is a primary nutrient, and is necessary in small quantities to sustain aquatic micro-organisms which constitute the base of the aquatic food chain. However, when present in large quantities, phosphorus can promote and sustain excessive growth of algae and other aquatic plants which results in "algal blooms" and in streams and rivers being choked with aquatic plants. The results can be harmful to fish and can impair the recreational uses of the waterway in question.

Chemical precipitation at sewage treatment plants can remove about 80 percent of the phosphorus contained in raw municipal sewage. By 1976, most municipal sewage treatment plants in southern Ontario will be using the chemical precipitation process to remove phosphorus. Many plants are already doing so. Studies are currently underway to determine the magnitude and significance of phosphorus pollution from agricultural land drainage. Control measures to halt the spread of water-polluting phosphorus from this agricultural source will also be evaluated and implemented as required.

Municipal and industrial sewage, urban storm runoff, agricultural drainage, and most other sources of wastewater contain a variety of other polluting materials such as particulate solids, salts, and heavy metals. Conventional waste treatment methods can remove only some of these materials. However, salts and dissolved metals are persistent and can pass through a sewage treatment plant virtually untouched. Even natural purification processes in the waters receiving these pollutants cannot remove them. As a result, the level of these undesirable materials builds up in lakes and rivers to the point where it can adversely affect the quality of municipal drinking water, and even supplies of water for irrigation and industrial use. Aquatic life can also be threatened by these persistent pollutants. Studies to evaluate the environmental impact and possible control procedures for these pollutants are continuing.

What Can Be Done?

It is apparent that nearly all of man's activities and many of the forces of nature contribute to some degree to water pollution. The natural sources of pollution cannot be eliminated, but for the most part natural pollution is insignificant when compared to pollution from man-made sources. It is everyone's responsibility to eliminate pollution and protect our waterways.

Governments at all levels have a role to play. The federal government can provide funds, facilities, and leadership for research and development of treatment and reclamation techniques. The provincial government can provide funds for construction of sewage treatment plants and reclamation. It can develop province-wide policies and procedures and undertake surveillance programs and special studies to aid in solving special problems. Municipal governments must ensure that sewage treatment plants within their municipalities are operating at maximum efficiency. They can improve their sewer systems to eliminate discharges of untreated wastewater. They must not allow solid waste disposal to contaminate ground water sources.

Industry can minimize pollution by recirculating water, establishing reclaiming and recycling processes for industrial wastes, and implementing special waste treatments prior to discharging sewage into municipal sewers or water courses. Individual citizens can assist by such means as conserving water and ensuring that waste disposal systems in the home and cottage are operating properly.

The biggest responsibility of the citizen,

however, is to become involved in environmental issues and to demand action from all levels of government and industry in the continuing battle against water pollution. Pollution is everyone's business.

1) Don't use lakes, streams or sewers as dumping areas for toxic materials. (weed-killers, insecticides, fertilizers, oil, paint or other wastes insoluble in water)

2) Endorse the construction of modern sewage treatment plants in your area.

3) When operating a pleasure boat (motor boat) make sure you do not have undue oil or gas spillages in the water. Wastes should be retained in a holding tank and disposed of on shore.

4) Keep river banks and shorelines clear when camping.

5) The use of pesticides and herbicides should be kept to a minimum.

6) Use low phosphate detergents.

7) Avoid discharging the following into a sewage or septic tank system: flammable or explosive materials (gasoline, benzene, etc.), corrosive or poisonous wastes (acids, pesticides, photographic chemicals, arsenic, etc.), large amounts of solids (feathers, sand, metal, wood, bones, paper, disposable diapers, etc.), grease or oils. These materials either are unsafe, will overload or upset sewage treatment processes, or will upset the environment into which the sewage is disposed.

8) Don't leave water taps running as this wastes our treated water supply.

9) Support citizen and government groups working for a better environment.

Some Activities For Students Studying Water Pollution

1. List as many natural sources of water pollution as you can.
2. List, in what you consider to be their order of importance, the man-made sources of water pollution.
3. Explain, with examples, the two general classes of pollutants.
4. Phosphorus in large quantities is a water pollutant. Explain why.
5. Discuss what you consider the role of governments — federal, provincial and municipal — should be in water pollution?
6. What other things, besides those mentioned in this fact sheet, can citizens do to combat water pollution?
7. Visit a local water or sewage treatment plant and attempt to get an interview with the plant manager to discuss the problems related to plant operations.
8. Obtain, through your teacher, films on water and/or water pollution such as;
   - i) **River With A Problem,** 28 min., color, National Film Board;
   - ii) **The Rise And Fall Of The Great Lakes,** 16 min., color, National Film Board;
   - iii) **The Invisible River, The River Must Live,** or **Environment Ontario,** available from Modern Talking Picture Service, 1943 Leslie Street, Don Mills, Ontario. (phone 1-416-444-7347)
9. Obtain further reading material on the subject of water pollution. A few of the many possible books include;
   - i) **Freshwater Pollution** by Peter Larkin, McGill-Queen's University Press, Montreal, 1974;
   - ii) **What You Can Do About Pollution** by John Fisher, Longmans, Don Mills, 1971;
   - iii) **Guidelines And Criteria For Water Quality Management In Ontario,** Ontario Ministry of the Environment, July, 1974.
10. The accompanying table lists the physical and chemical water quality criteria used by the Ministry of the Environment for public surface water supplies (note the microbiological and radioactivity criteria are not included).

    Since treatment processes exist which can convert any raw water (with a few minor exceptions) to potable water, it is necessary to define a commonly accepted treatment system which can produce a potable water at a reasonable cost. For the purposes of the criteria, such a system has been defined to consist of coagulation, flocculation, sedimentation and rapid sand filtration; the use of chemicals is restricted by definition to the commonly used coagulants and chlorine for disinfection.

    Two types of criteria have been established, namely the Permissible Criteria and the Desirable Criteria. Waters meeting both of these criteria are acceptable for treatment by the defined treatment process stated above. Waters meeting the Desirable Criteria provide for a greater margin of safety.

It should be borne in mind that the values given under the Permissible Criteria cannot be considered as maximum single sample values. These criteria should not be exceeded over substantial portions of time. If this should occur, then it will become necessary to determine the cause and initiate corrective action. The frequency and variety of sampling should be based on the findings of a comprehensive pollution survey.

As **an advanced study,** a student may wish to research the importance (public health aspects) of any one or more of the water constituents listed in the accompanying tables.

WATER QUALITY CRITERIA FOR PUBLIC SERVICE WATER SUPPLIES.

(Unless otherwise indicated, units are mg/l.)

Constituent or Characteristic	Permissible Criteria	Desirable Criteria
Physical		
Colour (platinum-cobalt)	75 units	< 5 units
Odour	Readily removable by defined treatment	Absent
Turbidity	— do —	Absent
Temperature	85°F	Pleasant tasting
Inorganic Chemicals		
Ammonia	0.5 (as N)	< 0.01
Arsenic*	0.05	Absent
Barium*	1.0	Absent
Boron*	1.0	Absent
Cadmium*	0.01	Absent
Chloride*	250	< 25
Chromium* (hexavalent)	0.05	Absent
Copper*	1.0	Virtually absent
Dissolved Oxygen	≥ 4 (monthly mean) ≥ 3 (individual sample)	Near saturation
Fluoride*	See footnote (1)	1.0
Hardness*	Acceptable levels will vary with local hydrogeologic conditions and consumer acceptance.	
Iron (filterable)	0.3	Virtually absent
Lead*	0.05	Absent
Manganese* (filterable)	0.05	Absent
Nitrate plus Nitrite*	10 (as N)	Virtually absent
pH range	6.0 - 8.5 units	Least amount of interference with treatment process
Phosphorus* (phosphates)	Not encourage growth of algae or interfere with treatment process	
Selenium*	0.01	Absent
Silver*	0.05	Absent
Sulphate*	250	< 50
Total Dissolved Solids* (filterable residue)	500	< 200
Uranyl Ion*	5	Absent
Zinc*	5	Virtually absent
Organic Chemicals(2)		
Carbon chloroform extract* (CCE)	0.15	< 0.04
Cyanide*	0.20	Absent
Methylene blue active substances*	0.5	Virtually absent
Oil and grease*	Virtually absent	Absent
Pesticides:		
Aldrin*	0.017	— do —
Chlordane*	0.003	— do —
DDT*	0.042	— do —
Dieldrin*	0.017	— do —
Endrin*	0.001	— do —
Heptachlor*	0.018	— do —
Heptachlor epoxide*	0.018	— do —
Lindane*	0.056	— do —
Methoxychlor*	0.035	— do —
Organic phosphates plus carbamates*	0.1	— do —
Toxaphene*	0.005	— do —
Herbicides:		
2,4-D plus 2,4,5-T, plus 2,4,5-TP*	0.1	— do —
Phenolic Substances*	Virtually absent	— do —

* The defined treatment process has little effect on the constituents.

(1)

Annual Avg. of Max. Daily Air Temp. F.	Recommended Limit for Fluoride mg/l
50.0 to 53.7	1.7
53.8 to 58.3	1.5
58.4 to 63.8	1.3

(2) Organic chemicals should not be present in concentrations as to cause adverse tastes and odours which cannot be removed by the defined treatment and/or by chlorination only.